International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development (IJCSEIERD)
ISSN (P): 2249-6866; ISSN (E): 2249-7978
Vol. 7, Issue 5, Oct 2017, 55-66
© TJPRC Pvt. Ltd.

TRANS STELLAR
•Journal Publications •Research Consultancy

ASSESSMENT OF ENERGY CONSUMPTION DUE TO CLUSTER REDEVELOPMENT

AR. INSIYA KAPASI[1] & ROSHNI UDYAVAR YEHUDA[2]

[1]Review Paper, Rachana Sansad's Institute of Environmental Architecture, Mumbai, India

Yashwantrao Chavan Maharashtra Open University (YCMOU), Nasik, India

[2]Professional, Head of Department and Research Guide, RachanaSansad's

Institute of Environmental Architecture, Mumbai, India

ABSTRACT

Cluster Redevelopment is a new concept in the city of Mumbai and its regulations was laid down by the government in 2009. It involves redeveloping a group of buildings defined by a certain boundary as specified by the laws of the respective city, state, province or country which may be dilapidated or approved for redevelopment. How would this development affect energy consumption? This review attempts to review the methods and parameters to assess change in energy consumption due to Cluster Redevelopment.

In the present work, methods of assessment to determine increase or decrease in energy consumption in cluster redevelopment based on different criteria such as carpet area, building envelope and its architectural elements along with the present scenario of energy consumption are discussed. This paper also discusses techniques by which reduction in energy consumption can be achieved.

KEYWORDS: Cluster Redevelopment, Mumbai, Energy Consumption & Energy Efficiency

Received: Aug 19, 2017**; Accepted:** Sep 04, 2017; **Published:** Sep 12, 2017; **Paper Id.:** IJCSEIERDOCT20176

Original Article

INTRODUCTION

Cluster redevelopment adds a new dimension to the urban renewal projects and aims to provide an avenue to profitably develop the dilapidated structures in the old city area which will also add the required infrastructure while minimizing the impact on the environment. The Energy Consumption in dilapidated buildings would be different to that of the new redeveloped buildings.

Cluster development is an approach to new development in a clustered format where a group of structures is developed together, which is usually termed as conservation design wherein a number of regional terms are applied. It involves development of residential or even commercial sector without hampering the area's environmental features and allowing more of open space. The site area in a cluster development normally covers an extensive area.(Church & knaap, 2017).

History of Development in Mumbai

Mumbai is a city which has been under many rulers ranging from the Hindu Rulers to Portugals where the main development of infrastructure, forts and churches were built to the East India Company and now the Democratic India. Mainly the increase in development started from the Portuguese times, as trade was introduced for the traders from Gujarat, which led to the increase in construction of mills. The opening of the Suez Canal,

improved trade opportunities of business in Mumbai leading it to be developed as a port city and amongst the important cities of India due to which many businesses started flourishing leading to increase in population and development. Businessmen started settling with their families for which traditional kind of low rise mansions were built most of them being loaded bearing from where the residential sector started evolving. (British Library, Bombay) Therefore Mumbai's oldest areas in the heart of old city consists of mostly mixed used tenanted chawls many of which were constructed 100 years ago, out of which many tenanted areas have been converted into ownership.(Master & Dravid, 2015)**.**

Redevelopment in Mumbai

Mumbai is at present the commercial capital of India and an important economic center of the world. Over the years, the population of Mumbai has increased to a large extent due to infiltration of people migrating from different parts of the country and the world, leading to the need for high end infrastructure and development in all sectors.

The Maharashtra housing board which was formerly known as 'Bombay Housing Board' was established post-independence in 1948 which undertook the construction of residential buildings under various housing schemes. This organization started immediately post-independence since businesses and population were on a rise. Maharashtra Housing and Area Development Authority (MHADA) covered the area of whole of Maharashtra state except the Vidharba region. As the open spaces of Mumbai started undergoing development due to increasing needs there wasn't much scope for further development of various sectors ranging from residential, commercial, transport, etc. thus needing the concept of redevelopment. (Maharashtra Housing and Area Development Authority (MHADA), 2008)**,**

The need for redevelopment started rising due to lack of open space in the city and increasing population. The redevelopment work started generating interest in Mumbai for the first time in 1991 when the Maharashtra government formulated regulations for the segment of redevelopment. There were very few projects that took interest under this segment because the house owners lacked clarity about the regulations and developers felt there was very little incentive in undertaking this kind of projects. This segment attracted more builders from 1999 when the regulations allowed for construction of additional flats at market price which gained momentum since past couple of years and became an integral part of the portfolio of the high end builders like Hiranandani, Raheja Group, Godrej Properties, Oberoi Realties, Wadhwa Group etc. Different parts of Mumbai being owned by different Authorities and organizations, complete redevelopment of the whole city is not possible but structures which are in old and dilapidated could be redeveloped. (Malhotra, 2013)

Variations in Redevelopment Norms of DCR 33/7 and Cluster Redevelopment DCR 33/9 in Mumbai

Redevelopment is a process for urban renewal where dilapidated buildings are redeveloped which is known as redevelopment of cessed buildings. Cessed buildings are buildings whose tenants pay tax in the form of rent which implies as 'Repair Fund' which is paid to the Maharashtra Housing Authority and Area Development (MHADA) for special provisions of repairs and reconstruction of dilapidated buildings**.**(Municipal Corporation of Greater Mumbai (MCGM), 1991)**.**The Section 33/7 was laid down in 1991 which laid the concepts of redevelopment and Section 33/9 were notified in 2009 by the Government of Maharashtra which laid the foundation of cluster redevelopment in the city. Section 33/7 Regulations are applicable only for island city whereas Section 33/9 is approved only in South Mumbai, this norm is not sanctioned in the suburban areas of Mumbai.

As per Section 33/7 of the redevelopment norms, the FSI on plot area is 2.5 or 50% incentive on rehab built up area whichever is more and incase of fungible FSI its 1 for the suburbs and 1.33 for south Mumbai and an additional FSI

of 35% on residential rehabilitation and 20% on shops which allows for construction of sale units creating incentives for the developer. Whereas Section 33/9gives an FSI OF 4 over the total plot area plus incentive FSI whichever is more.(Mehta, 2011)**.**This regulation is applicable to group of buildings having a minimum area of 4000 sq.mts and which is derived by a boundary around it. The boundary can be either roads or a drainage line surrounded on all four sides of the cluster. (Mehta, 2011)**.**Cluster redevelopment is a long process as the site is distributed over a huge extent, but the incentives of the shops rehabilitated has incentive of 30% which is more than the shops involved under section 33/9.On a whole cluster redevelopment not only generates capital incentives for the developer but also benefits the occupants as the minimum provision of a residential unit for the same cannot be less than 300 sq.ft. It also has incentives for development of social amenities and open spaces which is not present in case of redevelopment under section 33/7.(Municipal Corporation of Greater Mumbai (MCGM), 1991)**.** In cluster redevelopment, if the site has a land use belonging to the MCGM or MHADA it will be provided by the government body for development on a premium at the rate of 25% of the ready reckoner which is not the case in case of the redevelopment under section 33/7.(Mehta, 2011)**.**

ENERGY CONSUMPTION

In India the domestic sector consumes 23% of electricity and commercial sector consumes 8% of the total electricity consumption.(Ministry of Statistics and Programme Implementation Government of India, 2016)**.** The energy consumption of India is expected to grow at a much larger rate than many large developing countries. India's per capita consumption remains relatively low in 2035 which would roughly be where South Korea was in 1978 and Thailand in 1995. The rate of increase in Energy Consumption is 3.6% per annum.(Deb & Appley, July 2015)**.**

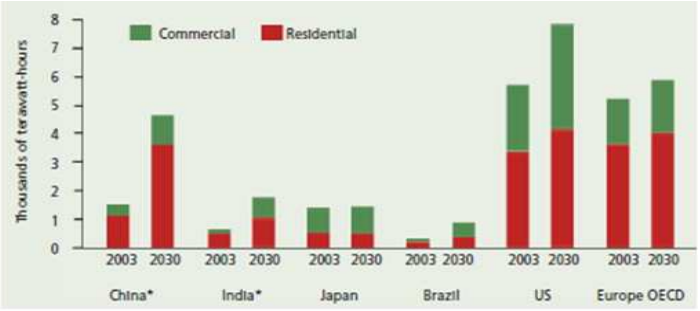

Figure 1: projection of Energy for Buildings by Region, 2003-30

Source: Center for Science and Environment

The maximum consumption of energy in residential sector has been at an increase for China, India and South Korea in 2015 due to rise in population as well as increased carpet areas and wants of people.

The **highest residential energy consumption of 10 countries** shows the **difference** in the **energy consumption of the residential sector** from **2000 to 2015** how it has changed **at a high rate.** The highest residential Energy Consumption was 4921 TWh in the world which was for China.

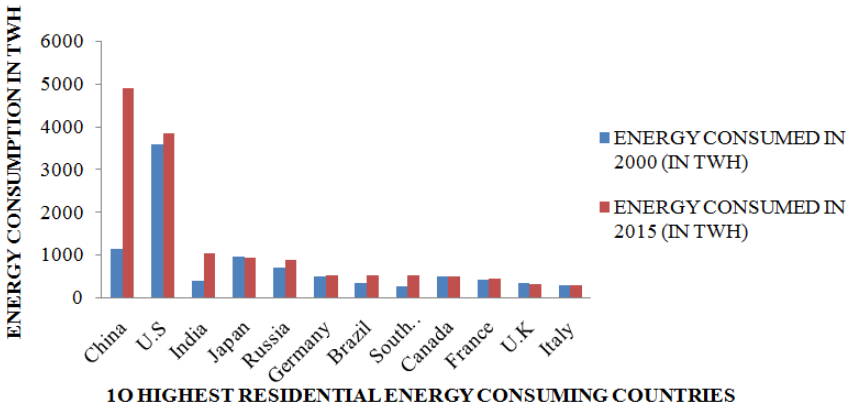

Figure 2: Highest Residential Energy Consumption of 10 Countries

Source: *World Power consumption | Electricity consumption | Enerdata*

https://yearbook.enerdata.net/electricity-domestic-consumption-data-by-region.html

As per a scenario analysis The Energy Consumption and Co2 emission levels in India would increase by 700% till 2050 as compared to the 2005 levels, which would be due to increase in India's constructed floor areas for residential as well as commercial sector. (Bureau of Energy Efficiency, April 2008)**.** It also states that the total residential floor area would be much larger than in the commercial floor area by 2030. The cluster redevelopment contributes to the increase in floor space area as per the studies. (Rawal, et al., September 2014)

Energy Consumption Patterns in India

Energy use in buildings, transportation systems and lighting networks represent a significant contribution to the overall energy consumption in urban and suburban areas.

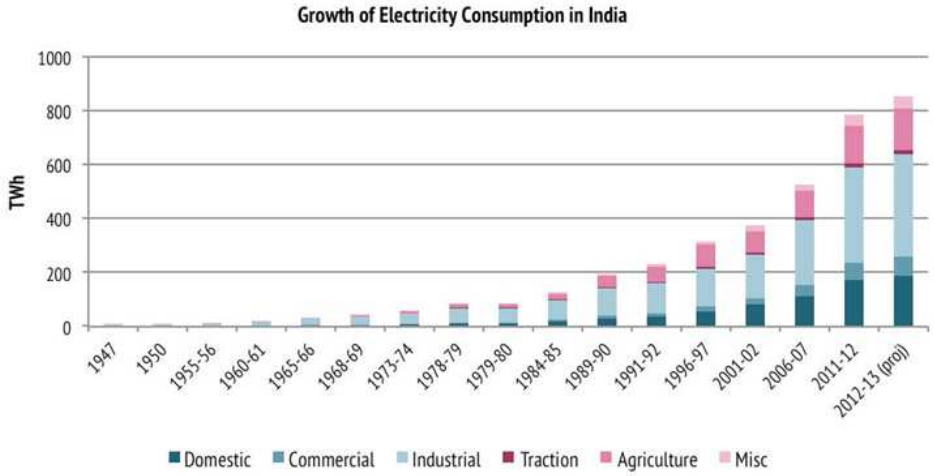

Figure 3: Growth of Electricity Consumption in India (Planning Commission, 2011)

Source: *CEA, 2012*

The residential buildings accounted for 22.9% of India's total energy consumption in 2012 which is two times

more than the commercial buildings in India. Currently the total energy consumption in the residential and commercial sector comes up with 30%, which includes 22% for residential sector and 8% for the commercial sector. The total electricity use and energy consumption are rising at a rate of 8% per year for these two sectors. (Sarl & Laussane, 2016)

Mumbai Energy Scenario

Mumbai at present lack of space leading to a cramped up development which comprises of a large population or rather a huge floor space of the home or office with modern facilities or sometimes with less number of people in huge flats who has a larger income rate and more demand for modern amenities and luxurious lifestyle. The cluster redevelopment caters to a huge population. In Mumbai Energy is supplied by three distributive companies, namely R-Infra, BEST and Tata power Company Tata Power is the largest generator of Electricity in Mumbai, which provides power to an area of 454 sq.km, in the city and suburbs.

R-Infra provides its electricity to over 2.7b million consumers in its licensed area. BEST supplies a total of 700 MW, with a consumption of 3.216 GWh (11,578 TJ). Mumbai's consumption of power on A.C's and Refrigerators is the highest among the household surveyed by The Energy Resources Institute (TERI) conducted in 2015, on behalf of the Bureau of Energy Efficiency. (Mumbai's Power Scenerio, Facts, 2010)**.**

Energy Consumption in Residential Sector

Inside residential buildings, electricity is primarily used for operating:

- Indoor lights
- Space-conditioning equipment such as fans and air-conditioners
- Appliances such as televisions, computers, refrigerators, mixers, microwaves, washing machines, and water heaters.

There are three main electricity consuming services that are found in almost all multi-storey residential complexes. These are: (Sarl & Laussane, 2016)

- Lighting of corridors, staircases, and outdoor areas
- Water pumps
- Lifts.

Energy Consumption in Commercial Sector

Electricity consumption of commercial buildings comprises of about 8% of the total electricity, supplied by the utilities in India. It is also stated that, the energy consumption has been growing at a rate of 11% - 12% annually, which is a much faster rate than the normal growth of 5% - 6%, throughout India. (Bureau of Energy Efficiency, April 2008)

Commercial and Residential Building Energy Consumption Baseline Study

A Baseline Study conducted (Bhatt, et al., 2005)**,** shows the energy consumption in the residential as well as commercial sector was quite low, than the facts reflected in the report of (Rawal, et al., September 2014)**.**

The Assessment of the study was based on various factors, such as specific energy consumption in relation to

floor area, power, electric power and the building connected load. The study found that, the total energy consumption in residential buildings accounted for one third and in commercial buildings, it accounted for two third of the total consumption, mainly due to Lighting and space cooling requirements. It was also found that, the energy consumed in Residential buildings came upto 1-3kwh/sq. m per month, which was 12-30 kWh/sq. m, per year and the peak load ranged between 30% to 100%, depending upon the climatic conditions. (Rawal, et al., September 2014)

Energy Consumption from Low Rise to High Rise Buildings

A high-rise structure is a multistoried structure, where an elevator is required by the occupants to reach their destination (Johnson, 2009)**.** The development of high-rise structures fits best, where urban infrastructure of the location and urban services are in place (Ali & Al-Kodmany, 2012). Traditional low rises consume low energy, but it cannot satisfy the needs of a densely populated area. In a low rise development, the number of occupants is quite low than of a high rise development. (Massachusetts Institute of Technology School of Architecture and Planning, 2010)**.** Construction of high-rise buildings require sophisticated foundations, structural systems to carry high wind loads, high end systems, which consume most amount of energy. High-rise structures have a high operational cost, elevator maintenance and emergency management, but the detailed and high quality designing of high-rise structures, as well as efficient materials help in reduction of operational costs. Considering tall buildings as a built form, consumes more material and energy resources for construction, operation and demolition from low rise or midrise buildings, but they have the potential to consume less energy than low rise buildings, due to many energy effective attributes, such as savings in travel time, reduction in losses of energy in power lines (Ali & Al-Kodmany, 2012).

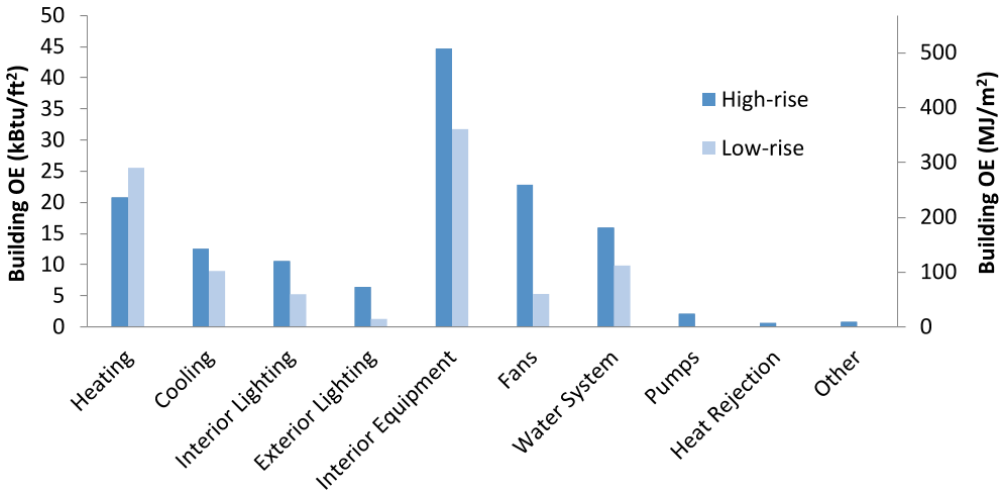

Figure 4

High-rise (STD 2013) *vs.* low-rise (IECC 2012) building end use operational energy (OE), for the U.S. DOE prototype building models. (Al-Kodmany, Peng Du, Wood, Stephens, & Song, 2015)

The roof on a building is the main source of energy loss. As compared to the energy loss through the roof of a low rise structure, with lower number of occupants will be much higher than the roof of a high rise structure, with higher density of population and built up area, in proportion to the amount of energy consumed by the structure.

The line of distribution of power in a high rise building is much shorter, causing reduction in power losses. Pumping water, in high-rise towers and elevators, which work against the force of gravity in a high rise building, consume

the most amount of energy. The 'zero energy buildings' today, produce an equal or more amount of energy than they consume. They can deliver energy to the city's power grid, these models are important for the building sector today, accounts for 30% to 40% of total energy use. (Ali & Al-Kodmany, 2012)

Energy Consumption Due to Change in Building Envelope

The high-rise buildings also consume quite some amount of energy, through the building façade. The features of the main building envelope, which influence the demand energy for cooling and thermal comfort in a residential unit, are listed below.

- Window to wall ratio
- Shading system for windows
- Window and wall properties
- Insulation properties of roofs
- Colour and finish of exterior surfaces (walls and roofs)

Window to Wall Ratio – WWR

The window to wall ratio in a building or a house, plays a vital role in accounting for the amount of heat gain for which, energy would be consumed. It is stated that, a limited glazed area and a WWR of 10% to 30% should be in bedrooms and 20% to 30% should be in living rooms. In residential complexes, where tall buildings are clustered together, day lighting in bedrooms and living rooms on the lower floors is reduced; this can be improved by increasing the window size (maximum WWR 30%). (Sarl & Laussane, 2016)

Shading System for Windows

As we go further south, in India, the northern façade of the building needs better protection, designed shading devices play a vital role in the reduction of heat gain, in a building. (Sarl & Laussane, 2016)

Window and Wall Properties

Design of windows is also an essential part, which can contribute to the decrease of electricity consumption by way of increasing cross ventilation, through windows. (Sarl & Laussane, 2016). Windows and walls in traditional low rise construction, are of a local and less efficient material, as they are old thus, increasing energy consumption. Use of well-designed windows with lesser U – values (rate of heat flow) and lesser U values of insulation and materials of walls can reduce huge energy consumptions. The solar heat gain transmittance and visible transmittance should be considered, for glass, as that is the main source of transmittance for day light.(Gregg, 2016)

Colour and Finish of Exterior Surfaces (Walls and Roofs)

Use of light colours and smooth finishes on the walls, opposite to the windows and light colours in interiors, and provision over deck insulation, and high reflective surfaces on roofs reduce heat gain, resulting in less consumption of energy. (Sarl & Laussane, 2016)

Energy Consumption Due to Change from Non Airconditioned to Airconditioned Spaces

Maximum of Mumbai's energy consumption is through A.C's, fridge and geysers. The old low rise structures that go in for development, usually don't have the modern amenities of Air Conditioners, hence, in Mumbai such structures use most of the energy through the fans, for space cooling. Due to redevelopment, the floor space area increases, leading to need for modern amenities for space cooling and lack of traditional methods of natural ventilation, lead to the use of the air conditioners, which result in the increase in the energy consumption. (Sarl & Laussane, 2016).

METHODS FOR ASSESSMENT OF ENERGY CONSUMPTION

Data Collection

There are various methods for data collection.

- Direct observation and measurement
- Questionnaires and Interviews via Survey
- Acquiring facts and secondary data.

The questionnaire formulated for the purpose of data collection through survey, should enable accurate information, which would meet the needs of potential data users, in a timely manner. It should be ensured that, collection of non – essential data is avoided, and the collected data should be having the prospects of a meaningful analysis and purposeful utilization. The work of data collection, data processing and tabulation should be facilitated. The sample size should be determined for the purpose of the survey, based on criteria's that would help in the assessment and quantification of energy consumption of the data, which is collected. (United Nations Statistics Division, 2005). Data collection in the residential sector can be based on, interior lighting, all appliances, heating and domestic hot water if electric, rooftop, elevators, common areas and recreational rooms. (Finch, Burnett, & Knowles, 2009), Habitable area of housing typologies, window to wall ratio, no. of people using the energy in the house, wall insulation, window and shading designs, building envelope. Data collection in the commercial sector can be based on building envelope, lighting, building type and overall building use, age of the building, occupation and area of premise, hours of use of the commercial premise, kind of appliances and machinery used for the occupation, and other mechanical systems. (Bureau of Energy Efficiency, April 2008). Acquiring electricity bills for both the sectors on an annual basis, stating average consumption and cost is also an important aspect in data collection, to quantify energy consumption.

APPROACHES OF ANALYSIS

Energy consumption can also be assessed by three types, which are Top Down Approach, Bottom up Approach and The Hybrid Approach. The energy models used for assessment of energy consumption can be classified into these three types, as they give a path towards the method for assessment of energy consumption (The World Bank, july,2008).

Energy consumption can be assessed by different approaches that are listed below, which are the recent modeling techniques, studied in India. The maximum assessment studies conducted in India are of the Bottom – up type (Deb & Appley, July 2015).

Table 1

Study	Approach	Type	
Expert group on Low Carbon Strategies	Activity Analysis Model	Top down	(Planning Commission, 2014)
The Energy Report - India	MARKAL location Model	Bottom up	(TERI, 2013)
Energy Emissions Trends and Policy Landscape	Integrated Assessment Model	Hybrid	(P R Shukla, 2015)
A Sustainable Development Framework for India's Climate Policy	Integrated Energy Model	Bottom up	CSTEP, 2015)
Energy Intensive Sectors of the Indian Economy	World Energy Model	Bottom up	(The World Bank, 2011)
India Energy Security Scenarios	Excel based simulation	Bottom up	(Niti Aayog, 2015)

Top Down Approach

Top Down Approach, depends upon availability of measured total energy demand values. (Akanden, 29th February, 2016,)**.** Top down Modeling Approach, or Top down econometric models are aggregate models of the entire economy, based on past trends to foresee the relationship between different sectors of the economy. On Top – Down Approach, the econometric models require a consistent set of data, over a reasonable long period of time. (Deb & Appley, July 2015).

Bottom Up Approach

Microeconomics approach, which is also known as end – use or bottom up approach, wherein micro level data is acquired, for the purpose of analysis, (The World Bank, july,2008) the bottom – up modeling approach, focuses on data collected by ground survey, that is by counting equipments and stocks, and adding up the energy consumption, by analyzing the efficiency and frequency of use of the equipment. This approach allows a more comprehensive analysis, by aggregating demand across sectors, which is then a product of activities and its levels and energy intensities. (Deb & Appley, July 2015).

Hybrid Approach

The hybrid approach is a combination of the partial elements, of the top down approach and bottom up approach, when assessment and analysis is done, using these elements which is a result acquired by the combination of these two methods (Deb &**Appley, July 2015).** The following are some approaches listed under the hybrid type (Marique & Sigrid Reiter)**.**

- **Topological Approach**: Based on energy consumption of households, according to the type of utilization namely detached, semi-detached, terraced houses, buildings.
- **Computational Approach**: Based on combining dynamic simulation tools and statistics of energy consumed, based on building area typologies.
- **Empirical Approach**: Based on assessment of energy consumed via transportation, as per everyday purpose.

- **Simplified Approach**: By calculating the energy consumed by public lighting.

CONCLUSIONS

The cluster redevelopment involves many capital incentives, for developers as well as for the people, as compared to redevelopment of a single dilapidated structure; it also conserves the environmental features, and increases the prospects of development of new social amenities and open spaces.

It is found that, the maximum increase in energy consumption is through the residential sector in cluster redevelopment, is mostly by space conditioning loads, which are the Air Conditioners and other cooling appliances, and building envelope. The rate of change of energy consumption is maximized, due to the redevelopment from low rise to high rise. The building envelope, which contributes for major space cooling, should be designed efficiently so as to help in the reduction of energy used. It is found that, the structures undergoing redevelopment, which are dilapidated comprise of inefficient techniques, traditional architectural features and poor services, resulting in major energy loss, due to which the amount of energy consumed is increased at a higher rate.

As per the studies conducted, the data on building type and age, housing area typologies and building envelope have to be analyzed, for assessment of energy consumption in the residential and commercial sector. This review is pursued to study the facts and methods, for assessment of energy consumption between a low rise old settlement of a typical typology which, when redeveloped under the cluster redevelopment and converted to high rise structures. The maximum assessment studies conducted in India are of the Bottom – up type, which is a comprehensive approach and helps in the formulation of detailed results. This approach gives an assessment, which is more authentic and based on the least amount of assumptions, since the data collected for the same is via ground surveys. The top down approach involves continuous assessment, for a long period of time.

REFERENCES

1. *Akanden, O. (29th February, 2016,). Performance Evaluation of Operational Energy uses in Refurbishment, reuse, and conservation of Heritage Buildings for optimum sustainability. ElsevierB. V.*
2. *Ali, M. M., & Al-Kodmany, K. (2012). Tall Buildings and Urban Habitat of the 21st Century: A Global Perspective. Buildings.*
3. *Al-Kodmany, K., Peng Du, Wood, A., Stephens, B., & Song, X. (2015). Life-Cycle Energy Implications of Downtown High-Rise vs.Suburban Low-Rise Living: An Overview and Quantitative Case Study for Chicago. Buildings, 22.*
4. *Bhatt, S., Rajkumar, N., Jothibasu, S., Sudirkumar, R., Pandian, G., & Nair, K. (2005). Commercial and residential building, Energy Labelling. Journal of Scientific and Industrial Research, 30 - 34.*
5. *British Library, Bombay. (n.d.). Bombay - History of a City. Maharashtra Tourism E Newsletter.*
6. *Bureau of Energy Efficiency. (April 2008). Energy Assessment Guide For Commercial Buildings. USAID | INDIA.*
7. *Church, J., & knaap, G. (2017). Cluster/ Conservation Development GLOBAL. University of Illinios, Local Community Resources.*
8. *Deb, K., & Appley, P. (July 2015). India's Primary Energy Evolution: Past Trends and Future Prospects. India Policy Forum 2015.*
9. *Finch, G., Burnett, E., & Knowles, W. (2009). Energy Consumption in Mid and High Rise Residential Buildings in British*

Columbia. BEST2 - Energy Efficiency.

10. *Greentech Knowledge Solutions Pvt.ltd. (2014). Baseline Scenario of Energy Consumption of Urban Multi- Storey Residential Buildings in India. 30th INTERNATIONAL PLEA CONFERENCE. Ahemadabad: CEPT University.*
11. *Gregg, A. D. (2016). Whole Building Design Guide. National Institute of Building Sciences.*
12. *Johnson, P. (2009). High-rise Building Definition, Development, and Use. Elsevier.*
13. *Maharashtra Housing and Area Development Authority (MHADA). (2008). MHADA. Retrieved May 13, 2017, from Maharashtra Government: https://mhada.maharashtra.gov.in/?q=history01*
14. *Malhotra, S. (2013, March 17). Rising from the rubble. Business Today In. Marques, A. -F., & Sigrid Reiter. (n.d.). A Method to Evaluate the Energy Consumption of Suburban Neighborhoods. HVAC & R Research, 01-21.*
15. *Massachusetts Institute of Technology School of Architecture and Planning. (2010). DESIGNING CLEAN ENERGY CITIES, New Approaches to Urban Design and Energy Performance. Jinan, China: The Energy Foundation, China.*
16. *Master, A., & Dravid, G. (2015). Ambitious Mumbai Project - Cluster Development for large scale Redevelopment of Urban Habitat. (pp. 01-09). New York: Council on Tall Buildings and Urban Habitat.*
17. *Mehta, C. (2011). Views on Cluster Development. Western India Regional Council of India, Solicitor (pp. 01-07). Mumbai: Conference on Real Estate.*
18. *Ministry of Statistics and Program Implementation, Government of India. (2016). Energy Statistics 2016. New Delhi.*
19. *Mumbai's Power Scenerio, Facts. (2010).*
20. *Municipal Corporation of Greater Mumbai (MCGM). (1991). Development Control Regulations (DCR).*
21. *Rawal, R., Shukla, Y., Srijan, D., Singh, M., Mewada, V., & Galsar, M. (September 2014). RESIDENTIAL BUILDINGS IN INDIA: ENERGY USE PROJECTIONS AND SAVINGS POTENTIALS. The Global Buildings Performance Network.*
22. *Sarl, E., & Laussane. (2016). DESIGN GUIDELINES FOR ENERGY-EFFICIENT MULTI-STOREY RESIDENTIAL BUILDINGS; Warm and Humid Climates. New Delhi: Bureau of Energy Efficiency and Greentech Knowledge Solutions Pvt. Ltd (GKSPL).*
23. *The World Bank. (July, 2008). RESIDENTIAL CONSUMPTION OF ELECTRICITY IN INDIA; DOCUMENTATION OF DATA AND METHODOLOGY,. India: Strategies for Low Carbon Growth.*
24. *United Nations Statistics Division. (2005). Designing Household Survey Samples: Practical Guidelines. New York: UNITED NATIONS PUBLICATION*